Effect of Abomasally Infused Methionine, Bypassed Methionine, and Hydrolyzed Feather Meal in Steers

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Story in Brief

Five mature Hereford steers fitted with rumen and abomasal cannulas were fed prairie hay *ad libitum* and 2.2 lb of 20 percent crude protein supplements with 65 percent of the protein from hydrolyzed feather meal (HFM) or the equivalent from coated slow release urea (SRU) with different levels of oleyl-methionine. Oleyl-methionine levels were 0, 30, 60, and 90 grams (g) per day. The levels 30 and 60 g were continuously infused in the abomasum and the 90 g level was fed orally.

Similar values for the treatments were observed with respect to daily dry matter intake, cellulose digestibility, nitrogen retained (g/day or as a percentage of the intake) or nitrogen digestibility. Digestibility of dry-matter was greater ($P<.05$) for rations containing HFM or SRU plus oleyl-methionine than SRU alone. Nitrogen reaching the abomasum was higher than intake for all treatments reflecting nitrogen recycling or poor recovery of the marker used.

Hydrolyzed feather meal produced less ammonia and microbial nitrogen in the abomasal digesta than the SRU supplements. No consistent effects of oleyl-methionine in microbial synthesis and bypass nitrogen were observed. Results suggest that methionine is not the first limiting amino acid for cattle fed poor quality forage.

Introduction

Several studies have indicated that certain nutrients may be limiting to cattle fed low quality roughages. Nitrogen certainly is the more deficient nutrient in these conditions and is generally supplied as plant protein or NPN.

Under some situations, however, the protein nitrogen supplemented could be used more advantageously to the animal if digested abomasally instead of going through the process of rumen fermentation. This is especially true for high quality protein which may be degraded and resynthesized to microbial protein of inferior quality in the rumen. The mircrobial protein has been shown in some studies to have low levels of certain amino acids, especially methionine and depending on the physiological function of the animal, methionine may be limiting to maximum performance.

Hydrolyzed feather meal, a byproduct of the poultry industry, contains approximately 80 to 90 percent crude protein and could possibly be used to increase bypass of protein since this product has a lower solubility than most of the plant proteins commonly used in cattle feeds. Also, its high content of the sulfur amino acid cystine could possibly spare part of the requirement of methionine.

The purpose of this experiment was to compare the effect on the nitrogen utilization by steers fed low quality roughage and urea of methionine treated to bypass rumen fermentation, methionine fed orally, methionine infused abomasally and hydrolyzed feather meal.

Materials and Methods

Five mature Hereford steers fitted with permanent rumen and abomasal cannulas were used. Treatments (Table 1) consisted of 20 percent crude protein supplements in which 65 percent of the protein was from hydrolyzed feather meal (HFM) or the equivalent from coated slow release urea[1] (SRU) with different levels of methionine treated with a mixture of glyceryl tristearate and oleic acid (oleyl-methionine).[2] The levels of oleyl-methionine added were 0, 30, 60 and 90 g per day to the urea based supplements. The 30 and 60 g levels of oleyl-methionine were infused continuously in the abomasum while the 90 g level was fed orally. The steers received 2.2 lb of supplement daily in one meal in addition to prairie hay fed *ad libitum*.

The experimental design was a 5 x 5 Latin square with each period consisting of an eight-day adjustment and a six-day collection period. Feces were collected daily from day 1 to 5 of each collection period, weighed and a 10 percent aliquot taken. The aliquots were composited for each period and then sampled for laboratory analyses. Urine was also weighed daily and a 5 percent aliquot kept and composited for analysis. Rumen and abomasal samples were taken on day 5 at 0, 4 and 8 hr relative to the a.m. feeding of the supplement and at 2, 6 and 10 hr after feeding on day 6.

Equal aliquots from abomasal samples were combined to provide a single animal composite for analysis. The composite was separated in solid and liquid phases by centrifuging at 10,000 g for 30 minutes. The solid sample was dried and ground; the liquid frozen and stored. Cellulose digestibility was estimated by placing cotton strips of known weight into the rumen for 48 hr on days 2 and 3 and weighing again after washing and drying.

Chromium sesquioxide (Cr_2O_3) and polyethylene glycol (PEG) were used as indicators to estimate the amount of solid and liquid digesta reaching the abomasum daily. Chromium sesquioxide was fed twice daily (7.5 g mixed with 200 g of ground corn) and PEG was infused in the rumen twice daily dissolved in water (37.5 g of PEG in 100 ml of water).

[1]Product of NIPAK Corp., Pryor, Oklahoma.
[2]Product of Degussa Chemicals Inc., Frankfurt, Germany.

Table 1. Composition and crude protein content of the rations.

Item	IRN[a]	Ration (% DM basis) HFM	SRU[b]
Ingredient, %			
Slow release urea		---	6.5
Feather meal, hydrolyzed	5-03-795	17.6	---
Corn, grnd.	4-02-992	53.6	45.6
Alfalfa, dehy. grnd.	1-00-525	10.0	10.0
Cotton seed hulls	1-01-599	11.8	30.4
Dicalcium phosphate	6-01-080	3.0	3.5
Potassium chloride	6-03-656	2.0	2.0
Trace mineral mix		2.0	2.0
Crude protein, total %		20.8	20.9

[a]International Reference Number. Atlas of Nutritional Data on United States and Canadian Feeds. 1971. National Academy of Sciences, Washington, DC.
[b]This ration was supplemented with 0, 30, 60 g (both infused abomasally) and 90 g (fed orally) of oleyl-methionine. Treatments were named SRU, SRU30, SRU60, SRU90, respectively.

Abomasal solid and liquid samples were also analyzed for ribonucleic acid (RNA). Microbial nitrogen was estimated from abomasal RNA assuming a nitrogen content of 13.2 percent in the RNA and that 10 percent of the microbial nitrogen was RNA nitrogen. Protein-nitrogen bypassing rumen degradation was estimated as non-ammonia nitrogen minus microbial nitrogen. Microbial protein was calculated as microbial nitrogen times 5.12 to correct for the nucleic acid content, which has limited value for the host animal (Kropp *et al.*, 1977a).

Results and Discussion

Dry matter intake was similar for the treatments (Table 2), however, a highly significant effect of animals and periods was observed for these parameters as well as for almost all other parameters studied. The SRU30 treatment resulted in greater dry matter intake and this probably affected the other parameters since an increase in dry matter intake is generally followed by an increase in the rate of passage of the diet and a decrease in total dry matter digestibility. As a result, greater abomasal solid and liquid digesta and lower ruminal and total dry matter digestibility were observed for this SRU30 treatment. Total solid and liquid digesta reaching the abomasum per day were similar for the treatments. Ruminal dry matter digestibility was lower ($P<.05$) for the SRU treatment. Cellulose digestibility estimated with cotton strips placed in the rumen was also similar for all treatments.

Total nitrogen intake (Table 3) was similar for the treatments except for the SRU30 treatment that had a higher nitrogen intake resulting from the greater dry matter intake as explained earlier. Also as a result from the greater dry matter intake for the SRU30 treatment was an increase ($P<.05$) in fecal dry matter for this treatment. Similar urinary nitrogen values were observed for the treatments. Apparently the methionine infused or fed was in excess of the animals' requirements of this amino acid and failed to show any response in nitrogen utilization. Nitrogen digestibility was also similar for all treatments.

Total nitrogen reaching the abomasum (nitorgen in the dry matter plus in the liquid) was in all treatments higher than total nitrogen intake (Table 4). This may reflect, to some extent, nitrogen recycling to the rumen, which can be in considerable

Table 2. Matter digestion, total solid and liquid digesta reaching the abomasum and cellulose digestibility.

	Treatment					
Item	HFM	SRU	SRU30	SRU60	SRU90	SE[a]
Dry matter intake (g/day)	9173	9181	9723	9028	9096	260.8
Abomasal solid digesta (g/day)	5170	5053	5737	5080	5120	230.0
Abomasal liquid digesta (1/day)	125.8	129.9	142.1	129.1	123.4	4.4
DM digested in the rumen (%)	44.3	45.8	40.3	43.7	43.6	2.2
Total DM digestibility (%)	60.3[c]	56.9[b]	57.8[bc]	59.8[c]	60.1[c]	.7
Cellulose digestibility (%)	15.3	19.6	19.7	17.9	19.0	.8

[a]Standard error.
[bc]Means in the same line with different superscripts are significantly different ($P<.05$).

Table 3. Nitrogen digestion and retention.

	Treatment					
	HFM	SRU	SRU30	SRU60	SRU90	SE[a]
N intake (g)	107.3	109.4	114.7	109.7	108.9	4.2
Fecal N (g)	50.7[b]	52.7[b]	57.5[c]	50.2[b]	50.9[b]	1.1
Urinary N (g)	17.9	18.9	19.0	17.5	18.0	0.2
N retained (g)	38.7	37.8	38.1	42.2	40.0	3.1
N retained, % of intake	35.6	34.0	33.3	38.1	36.5	1.5
N digested (%)	52.6	51.7	49.9	54.3	53.4	1.0

[a]Standard error.
[bc]Means in the same line with different superscripts are significantly different (P<.05).

Table 4. Nitrogen fractionation of abomasal digesta.

	Treatment					
Item	HFM	SRU	SRU30	SRU60	SRU90	SE[a]
N intake (g)	107.3	109.4	114.7	109.7	108.9	
Abomasal N (g)	146.4[b]	142.9[b]	163.2[c]	148.2[b]	143.6[b]	6.1
N influx (g)	39.1	33.5	48.5	38.5	34.8	3.3
N influx, % above intake	35.0	30.3	42.1	34.8	32.8	2.9
Ammonia N (g)	1.7[b]	5.1[d]	6.1[d]	5.3[d]	3.0[c]	0.2
Non-ammonia N (g)	144.8[b]	137.8[b]	157.2[c]	142.9[b]	140.7[b]	6.1
Microbial N (g)	70.3[b]	82.6[c]	95.2[d]	83.4[cd]	80.8[bc]	3.4
Microbial N, % of abomasal N	47.9	57.2	59.0	56.5	56.3	1.5
Bypass N (g)	74.4[c]	55.2[b]	61.9[bc]	59.5[b]	59.9[b]	3.9
Bypass N, % of abomasal N	50.9[c]	39.1[b]	37.2[b]	39.9[b]	41.7[b]	1.4
Microbial N/100 g DM digested (g)	9.7	10.3	13.5	11.4	10.5	0.5

[a]Standard error.
[bcde]Means in the same line with different superscripts are significantly different (P<.05).

Table 5. Ruminal ammonia nitrogen.

Time after	Supplements					
feeding	HFM	SRU	SRU30	SRU60	SRU90	SE[a]
Hr	0.3	2.1	1.8	1.6	0.9	0.4
2	0.6[b]	2.6[c]	2.4[c]	2.1[bc]	3.8[c]	0.4
4	0.8	2.9	1.0	1.9	1.9	0.4
6	0.7	1.6	1.5	1.5	1.0	0.2
8	0.8	1.6	1.1	0.9	1.2	0.2
10	0.7	0.7	0.5	0.9	1.2	0.1

[a]Standard error.
[bc]Means in a line with different superscripts are significantly different (P<.05).

amounts with low protein diets. The rumen ammonia nitrogen levels for the different times after feeding (Table 5) were not significantly different in most cases due to the high variability caused apparently by the ingestion of feed and water.

In general, very low rumen ammonia levels were observed indicating that conditions were favorable to nitrogen recycling to the rumen. However, the large amount of nitrogen influx into the rumen in this experiment may also result of incomplete recovery of the markers utilized. This is possibly true with PEG because the recovery was affected by cottonseed hulls present in the ration.

Although a correction factor was estimated by incubating a PEG solution with different amounts of cottonseed hulls for different times, the overestimation of the amount of liquid reaching the abomasum per day may be in part responsible for the results. Although the correction factor may lead to some errors in the absolute values estimated, the comparison or the relative difference among the treatments are thought to be valid.

The amount of ammonia nitrogen in the abomasal digesta was higher ($P<.05$) for the treatments containing SRU as expected. Little soluble nitrogen is present in the HFM according to data presented by Owens (1978). Non-ammonia nitrogen was higher ($P<.05$) in the SRU30 treatment; this may have resulted from the higher intake of dry matter in this treatment permitting more protein to bypass the rumen.

Hydrolyzed feather meal showed less microbial protein synthesis and more bypass ($P<.05$) than the SRU containing treatments; however, this apparently had no effect on nitrogen retention. Percent microbial nitrogen, bypassed nitrogen and microbial protein synthesized per 100 g of dry matter digested in the rumen were not significantly different for the treatments.

Under the conditions of this experiment methionine apparently was not the limiting factor for maximum nitrogen utilization. The requirement of this amino acid may have been met by the diet and further additions caused no effect on nitrogen utilization.

Literature Cited

Kropp, J. R., 1977, J. Anim. Sci. 45:844.

Owens, F. N., 1978a, Feedstuffs 50(28):23.